



Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

GCSE CHEMISTRY

F

Foundation Tier Paper 1

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	



J U N 2 1 8 4 6 2 1 F 0 1

1B/M/Jun21/E17

8462/1F

0 1

This question is about elements, compounds and mixtures.

0 1 . 1

Substance A contains only one type of atom.

Substance A does not conduct electricity.

Which type of substance is A?

[1 mark]

Tick (✓) one box.

Compound

☐*- They are ^{atoms} chemically combined.*

Metallic element

☐*- substances that conduct electricity*

Mixture

☐*- Mixtures are not chemically bond together but separated by physical means.*

Non-metallic element

☒

0 1 . 2

Substance B contains two types of atoms.

The atoms are chemically combined together in fixed proportions.

Which type of substance is B?

[1 mark]

Tick (✓) one box.

Compound

☒

Metallic element

☐*- substances that conduct electricity.*

Mixture

☐*- Mixtures are not chemically bond together but separated by physical means.*

Non-metallic element

☐*- They are one type of atom but do not conduct electricity.*

Turn over ►



0 1 3

What is the name of the elements in Group 0 of the periodic table?

[1 mark]

Tick (✓) one box.

Alkali metals

☐*They are group 1 elements.
Mainly metals.*

Halogens

☐*They are group VII. Usually non-
metals.*

Noble gases

☒

Transition metals

☐*Located at centre of the
periodic table.*

0 1 4

Which statement about the elements in Group 0 is correct?

[1 mark]

Tick (✓) one box.

All elements in the group are very reactive.

☐*- They are
chemically
unreactive*All elements in the group form negative ions. *They have
neither positive or negative ions. They are
stable.*☐

The boiling points increase down the group.

☒The relative atomic masses (A_r) decrease down the group.☐*They increase
down the
group.*

0 1 . 5

Neon is in Group 0.

What type of particles are in a sample of neon?

[1 mark]

Tick (✓) one box.

Atoms

☒

Ions

☐*ions are electrically charged particles.*

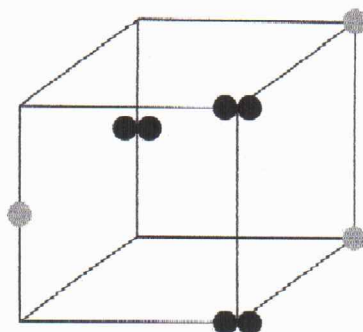
Molecules

☐*- group of two or more atoms held together by attractive forces by chemical bonds.*

0 1 . 6

Figure 1 represents part of the structure of an oxide of a metal.

Figure 1



Key

● Metal (X)

● Oxygen (O)

Determine the empirical formula of this oxide.

[1 mark]

Empirical formula is the simplest possible formula.

$$\begin{array}{cc} \text{X} & \text{O} \\ 3 & 6 \end{array}$$
Empirical formula = XO_2 *Divide
by 3*

$$\begin{array}{cc} \text{X} & \text{O} \\ \frac{3}{3} & \frac{6}{3} \\ 1 & 2 \end{array}$$

$$\underline{\underline{\text{XO}_2}}$$

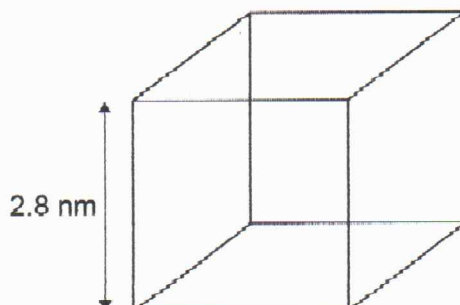
Turn over ►



A nanoparticle of a metallic element is a cube.

Figure 2 shows a diagram of the nanoparticle.

Figure 2



0 1 . 7

The surface area of a cube is given by the equation:

$$\text{surface area} = (\text{length of side})^2 \times 6$$

Calculate the surface area of the cube in Figure 2.

Give your answer to 2 significant figures.

[3 marks]

$$\begin{aligned} \text{Total surface area} &= (2.8 \text{ nm} \times 2.8 \text{ nm}) \times 2 = 15.68 \text{ nm}^2 \\ &+ (2.8 \text{ nm} \times 2.8 \text{ nm}) \times 2 = 15.68 \text{ nm}^2 \\ &+ (2.8 \text{ nm} \times 2.8 \text{ nm}) \times 2 = 15.68 \text{ nm}^2 \\ \text{Total surface area} &= 47.04 \text{ nm}^2 \\ &\approx \underline{\underline{47 \text{ nm}^2}} \end{aligned}$$

Surface area (2 significant figures) = 47 nm²



0 1 . 8

Fine and coarse particles of the metallic element are also cubes.

The length of a fine particle cube is 10 times smaller than the length of a coarse particle cube.

How does the surface area to volume ratio of the fine particle cube compare with that of the coarse particle cube?

[1 mark]

Tick (✓) **one** box.

Both surface area to volume ratios are the same.

☐

The surface area to volume ratio of the fine particle is 10 times greater.

☒

The surface area to volume ratio of the fine particle is 10 times smaller.

☐

10

Turn over for the next question

Turn over ►



0 2

This question is about chemical cells and batteries.

0 2 . 1

Three different types of battery can be used to power a TV remote control.

Table 1 gives information about these batteries.

Table 1

	Zinc-carbon battery	Alkaline battery	Nickel-metal hydride battery
Cost of battery in £ (pounds)	0.17	0.50	1.50
Rechargeable?	No	No	Yes
Time before needing to replace or recharge in months	5	12	8

Give one advantage of each type of battery.

[3 marks]

Zinc-carbon They are the cheapest compared to the others.Alkaline They have a long life span (longest in lasting).Nickel-metal hydride They are rechargeable.

0 2 . 2

Figure 3 shows a symbol printed on batteries.

Figure 3



This symbol shows that batteries should not be put in household waste.

Suggest why batteries should not be put in household waste.

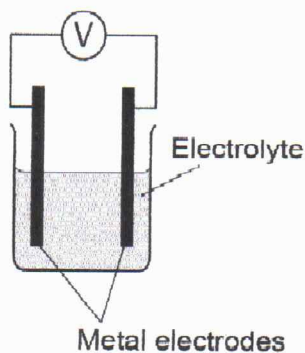
[1 mark]

The metal (alkaline waste) can be toxic thus being harmful and can cause pollution in landfill sites.



Figure 4 shows a chemical cell.

Figure 4



0 2 3 The order of reactivity of three metals is shown below.

Iron	(Most reactive)
Tin	↑
Copper	(Least reactive)

Which combination of metal electrodes would give the highest voltage in the chemical cell in **Figure 4**?

[1 mark]

Tick (✓) **one** box.

Copper and iron

☒

Iron and tin

☐

Tin and copper

☐

0 2 4 The voltage produced by the cell in **Figure 4** depends on the type of electrodes and the type of electrolyte.

Suggest **one** other factor that could affect the voltage produced.

[1 mark]

The temperature of the electrolyte solution.

Turn over ►



Do not write
outside the
box

0 2 5

Water is produced in a hydrogen fuel cell.

Complete the word equation to show the reaction that produces water in a hydrogen fuel cell.

[2 marks]

Hydrogen + Oxygen → water

8



0 3

This question is about Group 1 elements.

0 3 . 1

Complete Table 2 to show the electronic structure of a potassium atom.

[1 mark]

Table 2

Atom	Number of electrons	Electronic structure
Sodium	11	2,8,1
Potassium	19	2.8.8.1

0 3 . 2

Why do Group 1 elements have similar chemical properties?

[1 mark]

Tick (✓) one box.

They have the same number of electron shells.

☐They have same
electrons in outer
shell.

They have the same number of outer shell electrons.

☒

They have two electrons in the first shell.

☐

0 3 . 3

What is the type of bonding in sodium?

[1 mark]

Tick (✓) one box.

Covalent

☐

bonding between non-metals

Ionic

☐

Bond between metal and non-metal.

Metallic

☒

Turn over ►



Table 3 shows observations made when lithium, potassium and rubidium react with water.

Table 3

Element	Observations
Lithium	Bubbles slowly Floats Moves slowly
Sodium	1 Bubbles formed very quickly. 2 The atom melts into a ball and floats (darts on the surface).
Potassium	Bubbles very quickly Melts into a ball Floats Moves very quickly Flame
Rubidium	Sinks Melts into a ball Explodes with a flame

0 3 . 4 Give two observations you could make when sodium reacts with water.

Write your answers in Table 3.

[2 marks]



0 3 . 5

How does the reactivity of the elements change going down Group 1?

[1 mark]

The reactivity increases down the group.

0 3 . 6

Give two ways in which the observations in Table 3 show the change in reactivity going down Group 1.

[2 marks]

- 1 There is an increase in speed of movement of the elements on water.
- 2 The bubble production rate increases.

0 3 . 7

Which gas is produced when Group 1 elements react with water?

[1 mark]

Tick (✓) one box.

Carbon dioxide

☐

It is produced when carbonates react with acid.

Hydrogen

☒

Nitrogen

☐

Oxygen

☐

- Required in combustion.

Turn over ►



0 3 8 Sodium fluoride is an ionic compound.

Figure 5 shows dot and cross diagrams for a sodium atom and a fluorine atom.

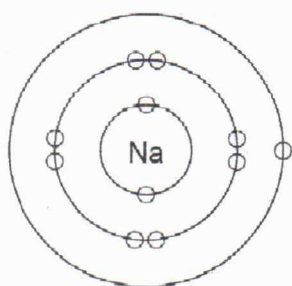
Complete Figure 5 to show what happens when a sodium atom and a fluorine atom react to produce sodium fluoride.

You should:

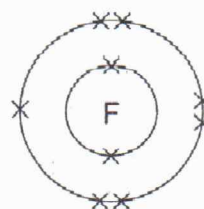
- complete the electronic structures of the sodium ion and the fluoride ion
- give the charges on the sodium ion and the fluoride ion.

[3 marks]

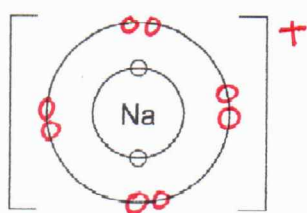
Figure 5



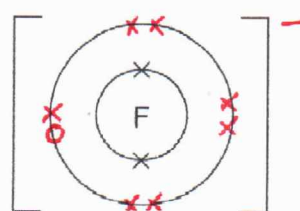
Sodium atom



Fluorine atom



Sodium ion



Fluoride ion

Sodium atom loses its outer electron to form a positively charged ion while fluorine gains the electron to form negatively charged ion.



0 4

A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

1. Measure 50 cm³ of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

Table 4 shows the student's results.

Table 4

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	X
Zinc	18	16	18	20	18

0 4 . 1

Calculate the mean temperature increase X for magnesium in Table 4.

Do not include the anomalous result in your calculation.

[2 marks]

$$\begin{aligned}
 \text{Mean} &= \frac{54 + 50 + 55}{3} \\
 &= \frac{159}{3} \\
 &= 53^{\circ}\text{C}
 \end{aligned}$$

$$X = 53^{\circ}\text{C}$$



0 4 . 2

Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use Table 4.

[1 mark]

Most reactive

Magnesium

Zinc

Least reactive

Cobalt

0 4 . 3

The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use Table 4.

[1 mark]

The mean temperature increase for zinc is 18 ± 2 °C

0 4 . 4

What type of variable is the volume of hydrochloric acid in this investigation?

[1 mark]

Tick (✓) one box.

Control

☒

- Variables that may affect the results of the experiments that need to be monitored.

Dependent

☐

- The Variable that is measured to determine the outcome of an experiment.

Independent

☐

- Only the variable that should be changed throughout the experiments.

0 4 . 5

Suggest one way of improving step 3 in the method to give results which are more repeatable.

[1 mark]

They should use the same mass of
Metal (powder).

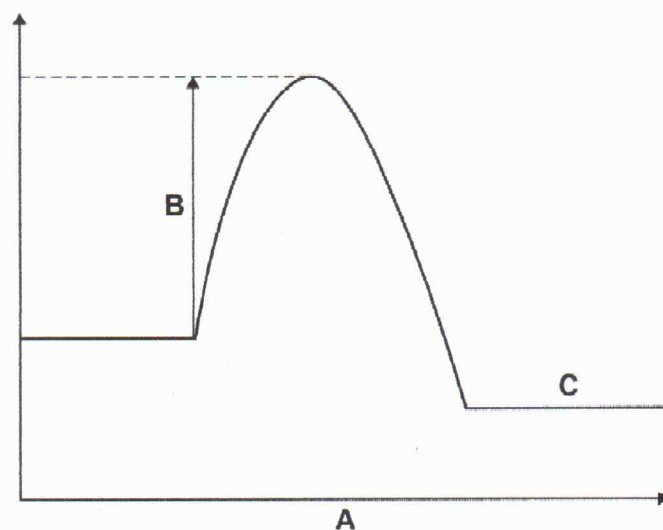
Turn over ►



0 4 . 6

Figure 6 shows a reaction profile for the reaction of magnesium with hydrochloric acid.

Figure 6



What do labels A, B and C represent on Figure 6?

Choose answers from the box.

[3 marks]

activation energy	energy	overall energy change
products	progress of reaction	reactants

A Progress of reaction.

B Activation energy.

C Products.



0 5

This question is about acids and alkalis.

0 5 . 1

Which ion do acids produce in aqueous solution?

[1 mark]

Tick (✓) **one** box. H^+ ☒ OH^- ☐ O^{2-} ☐

(alkali)

0 5 . 2

Acids react with alkalis.

What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

Decomposition

☐

- Compounds broken down into elements by heat.

Electrolysis

☐

- chemical change caused by passing an electric current through a compound in molten or in solution.

Neutralisation

☒

Redox

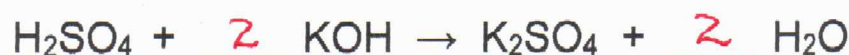
☐

- Reaction that involves both oxidation and reduction.

0 5 . 3

Balance the equation for the reaction between sulfuric acid and potassium hydroxide.

[1 mark]



0 5 . 4

Universal indicator turns purple in potassium hydroxide solution. (strong alkali)

What is the pH of the solution?

[1 mark]

Tick (✓) **one** box.

1

☐

Strong acid pH.

4

☐

Weak acid pH.

7

☐

Neutral pH.

14

☒

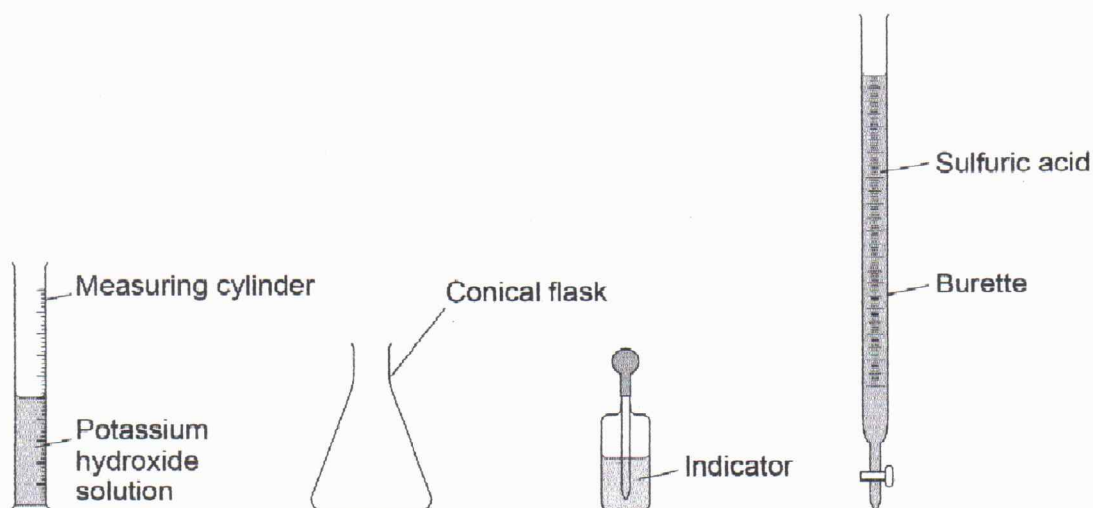
Turn over ►



A student does a titration to find the volume of sulfuric acid that reacts with 25 cm^3 of potassium hydroxide solution.

Figure 7 shows the equipment used.

Figure 7



0 5 . 5 The 25 cm^3 of potassium hydroxide solution is measured with the measuring cylinder.

Which piece of equipment could the student use to measure the 25 cm^3 of potassium hydroxide solution more accurately?

[1 mark]

Tick (✓) one box.

Beaker

☐

used to hold and heat liquids.

Evaporating basin

☐

Used to recover dissolved solids by evaporation.

Pipette

☒

Test tube

☐

- Used for storing, mixing and heating small amounts of chemicals.



0 5 . 6

Describe how the student would use the equipment in Figure 7 to complete the titration.

[5 marks]

You are required to add the Potassium hydroxide solution to the conical flask. Then add a few drops of Indicator to the solution in the conical flask. Add the sulfuric acid from the burette and perform a rough titration by taking burette reading and running in the solution while swirling the conical flask vigorously. Make sure the colour of the Indicator changes. Then read the volume from the burette. Record the volume to the nearest 0.05 cm^3 . You may repeat the titration to achieve two concordant results to increase accuracy.

10

Turn over for the next question

Turn over ►



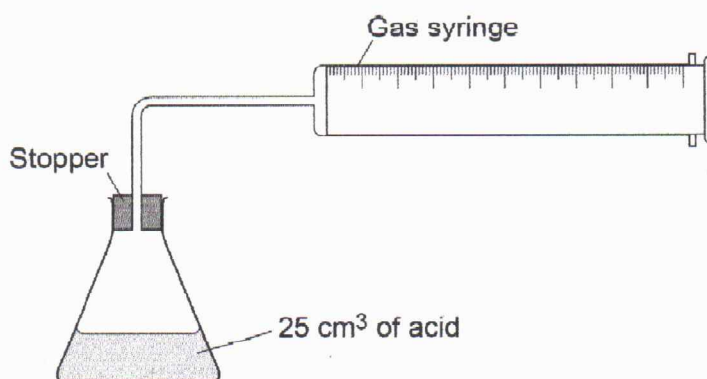
0 6

This question is about metal carbonates.

A student investigated the reaction of copper carbonate with an acid.

Figure 8 shows the apparatus.

Figure 8



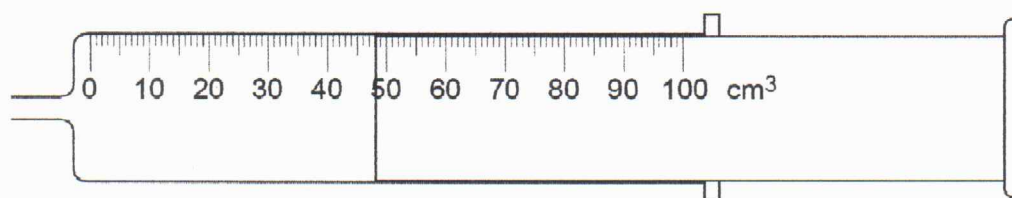
This is the method used.

1. Pour 25 cm³ of the acid into a conical flask.
2. Weigh 0.10 g of copper carbonate.
3. Remove the stopper and add the copper carbonate to the flask.
4. Quickly replace the stopper.
5. Record the maximum volume of gas collected in the gas syringe.
6. Repeat steps 1 to 5 with different masses of copper carbonate.

0 6 . 1

Figure 9 shows the gas syringe during the experiment.

Figure 9



What is the reading on the gas syringe?

[1 mark]

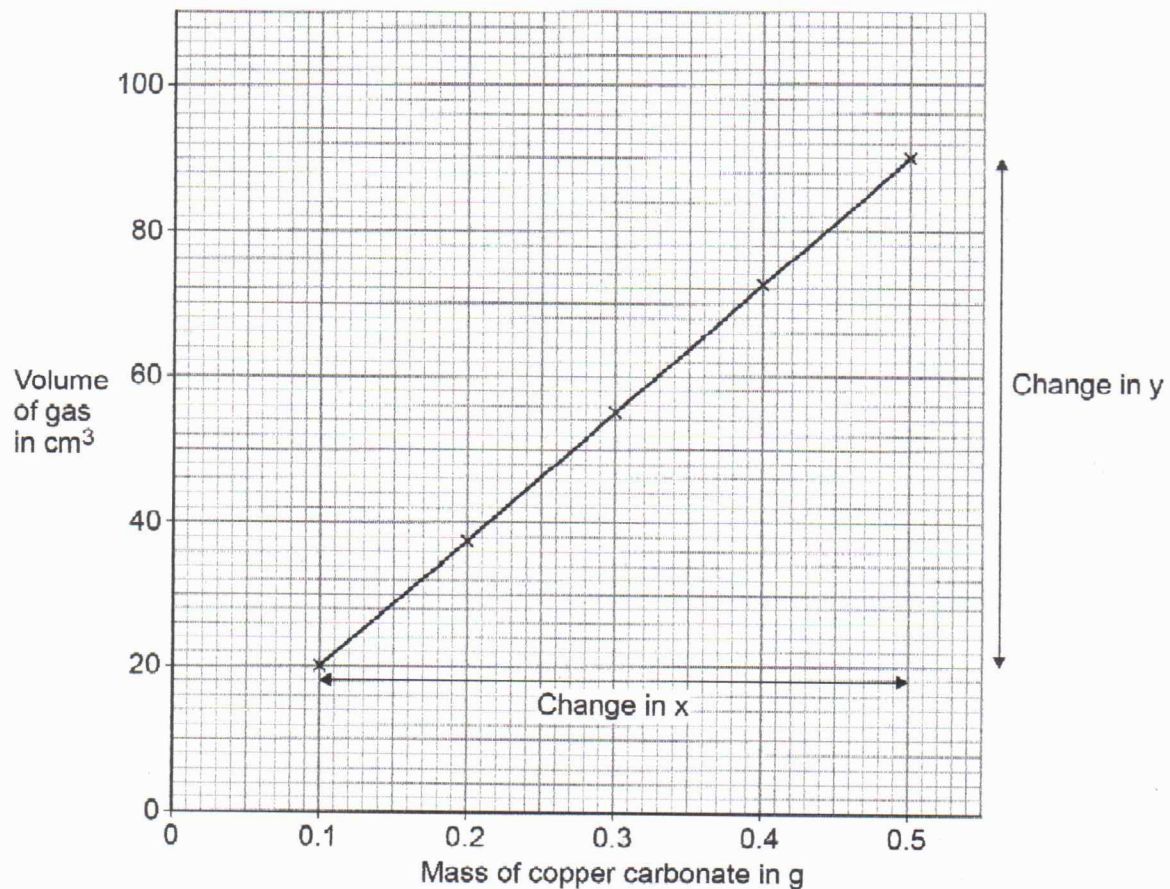
48 cm³



0 6 . 2 The student plotted the results on a graph.

Figure 10 shows the student's graph.

Figure 10



Determine the gradient of the line of best fit.

You should:

- calculate the values of the change in y and the change in x
- calculate the gradient of the line of best fit.

[4 marks]

Change in y = $90\text{cm}^3 - 20\text{cm}^3 = 70\text{cm}^3$ cm³

Change in x = $0.5\text{g} - 0.1\text{g} = 0.4\text{g}$ g

Gradient $\text{Gradient} = \frac{70\text{cm}^3}{0.4}$

$\text{Gradient} = \frac{\text{change in y}}{\text{change in x}} = \frac{70}{0.4} = 175\text{cm}^3/\text{g}$

Gradient = 175 cm³/g

Turn over ►



0 6 . 3

Copper chloride was produced in the reaction.

Which acid reacts with copper carbonate to produce copper chloride?

[1 mark]

Tick (✓) one box.

Hydrochloric acid

☒

Nitric acid

☐*The product will be copper nitrate*

Sulfuric acid

☐*The product will be copper sulfate.*

0 6 . 4

The reaction between copper carbonate and the acid produced a gas.

What was the gas?

[1 mark]

Tick (✓) one box.

Carbon dioxide

☒*When carbonates react with acids
the products are salt, Carbon dioxide
and Water.*

Chlorine

☐

Hydrogen

☐*When a metal reacts with an
acid product is salt and hydrogen
gas.*

Oxygen

☐*Required in combustion reactions.*

A different student produced a pure, dry sample of copper chloride using the same reaction.

This is the method used.

1. Add excess copper carbonate to the acid.
2. Filter the mixture.
3. Heat the solution gently until crystals start to form.
4. Leave for 24 hours.
5. Remove the crystals.
6. Rinse with water and dry the crystals.

0 6 . 5 Why was the solution heated gently in step 3?

[1 mark]

Tick (✓) **one** box.

To evaporate acid

☐

To evaporate copper carbonate

☐

To evaporate water

☒

0 6 . 6 How should the solution be heated gently in step 3?

[1 mark]

It should be heated using a water bath
or an electric heater.

9

Turn over ►



0 7

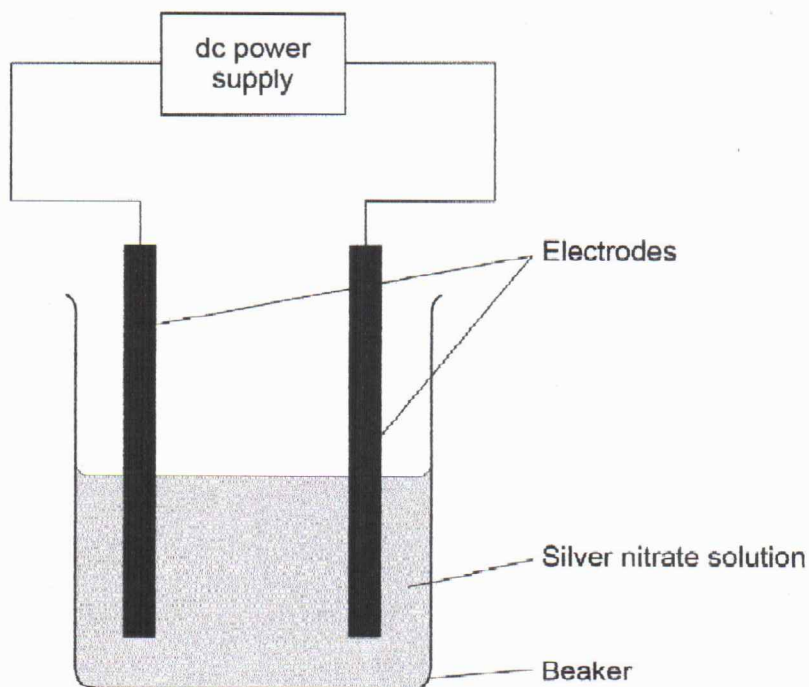
This question is about electrolysis.

Some students investigated the electrolysis of silver nitrate solution.

This electrolysis produces silver at the negative electrode.

Figure 11 shows the apparatus.

Figure 11



This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in Figure 11.
3. Switch on the power supply.
4. Switch off the power supply after five minutes.
5. Rinse the negative electrode with water and allow to dry.
6. Reweigh the negative electrode.
7. Repeat steps 1 to 6 for different times.

Turn over ►



0 7 . 1

Some silver did not stick to the negative electrode but fell to the bottom of the beaker.

The students needed to weigh this silver.

How could the students separate the silver from the silver nitrate solution?

[1 mark]

Tick (✓) one box.

By chromatography

☐

separates out mixtures

By crystallisation

☐

separates a soluble solid from a liquid.

By distillation

☐

used to separate out solutions

By filtration

☒

separates an insoluble solid from a liquid.

Table 5 shows the students' results.

Table 5

Time in minutes	Mass of silver in g
0	0.00
5	0.06
10	0.12
15	0.18
20	0.24
25	0.30



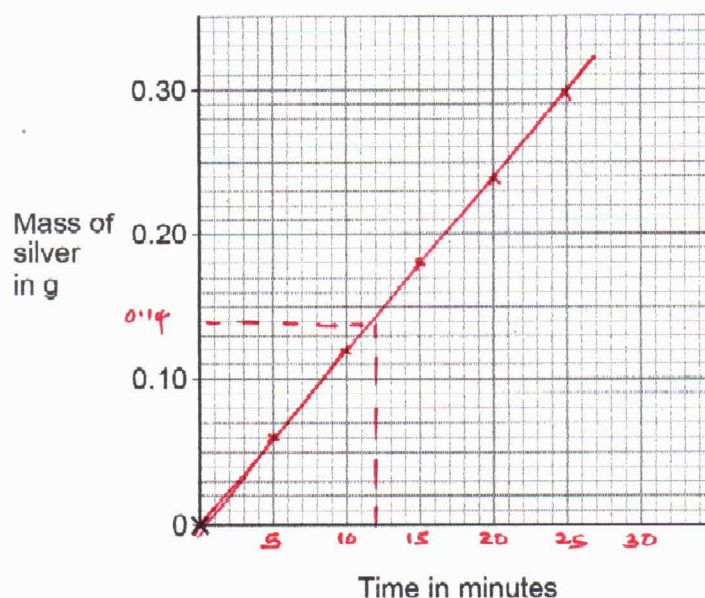
0 7 . 2 Draw a graph on Figure 12.

You should:

- use a suitable scale for the x-axis
- plot the data from Table 5
- draw a line of best fit.

[4 marks]

Figure 12



0 7 . 3 Determine the mass of silver that would be produced after 12 minutes.

Use Figure 12.

[1 mark]

Mass of silver = 0.14 g

Question 7 continues on the next page

Turn over ►



0 7 . 4 A student investigated the electrolysis of two aqueous salt solutions.

Hydrogen is produced at the negative electrode when the metal in the salt solution is more reactive than hydrogen.

Complete Table 6 to show what the student would **observe** at the negative electrode for each salt solution.

[2 marks]

Table 6

Salt solution	Observation at negative electrode
Copper sulfate	A red brown solid is formed.
Sodium chloride	Bubbles are seen at the electrode.

0 7 . 5 A teacher demonstrates the electrolysis of molten lead bromide.

The products at the electrodes are lead and bromine.

Why should the teacher do the demonstration in a fume cupboard?

[1 mark]

The product formed is poisonous thus need to be carried out in a fume cupboard.

0 7 . 6 Two other molten compounds are electrolysed.

Complete Table 7 to show the molten compounds and the products.

[3 marks]

Table 7

Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode
Zinc chloride	Zinc	Chlorine
Potassium iodide	Potassium	Iodine



0 8

This question is about carbon and its compounds.

Fullerenes are molecules of carbon atoms.

The first fullerene to be discovered was Buckminsterfullerene (C_{60}).

0 8 . 1

What shape is a Buckminsterfullerene molecule?

[1 mark]

It is spherical in shape.

0 8 . 2

Give one use of a fullerene.

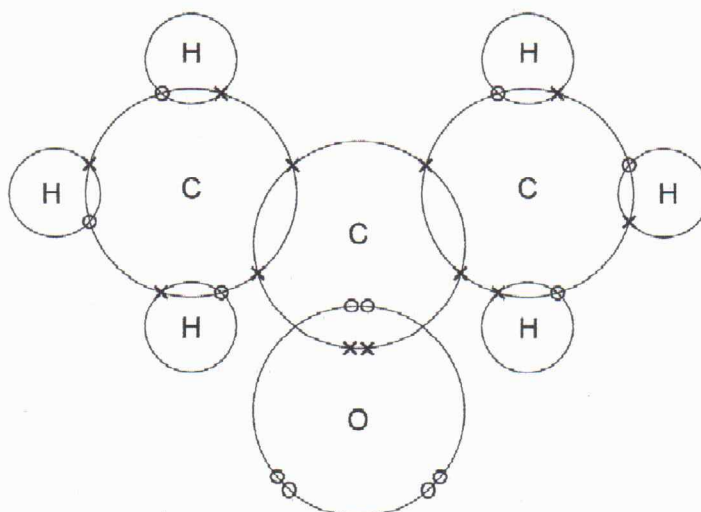
[1 mark]

- Fullerene is used in reduction of bacterial growth.
- Fullerene is used in strengthening of materials for cylindrical fullerenes.
- Used as drug delivery in the body.

Propanone is a compound of carbon, hydrogen and oxygen.

Figure 13 shows the dot and cross diagram for a propanone molecule.

Figure 13



0 8 . 3

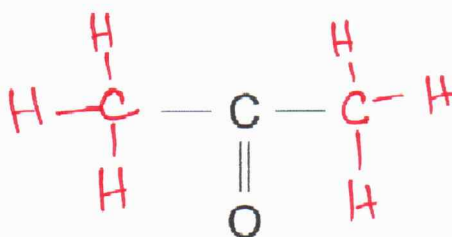
Complete Figure 14 to show a propanone molecule.

Use a line to represent each single bond.

Use Figure 13.

[1 mark]

Figure 14



0 8 . 4

Determine the molecular formula of propanone.

Use Figure 13.

[1 mark]

Molecular formula = C₃H₆O

0 8 . 5

Propanone is a liquid with a low boiling point.

Why does propanone have a low boiling point?

[1 mark]

Tick (✓) one box.

The covalent bonds are strong.

☐

- Propane has single covalent bonds.

The covalent bonds are weak.

☐

- Intermolecular force is a polar covalent bond.

The intermolecular forces are strong.

☐

They are weak.

The intermolecular forces are weak.

☒

- These are the forces between the molecules.

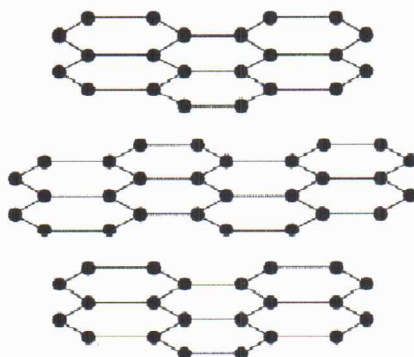
Turn over ►



0 8 6

Figure 15 represents the structure of graphite.

Figure 15



Explain why graphite is:

- a good electrical conductor
- soft and slippery.

You should answer in terms of structure and bonding.

[6 marks]

Graphite bonds are covalent bonded. The graphite have three covalent bonds per carbon atom, creating layers of carbon atoms, therefore one carbon atom is delocalised (free) and can move thus conducts electricity. The graphite structure is layered in interlocking hexagonal rings with weak intermolecular forces between layers and no covalent bonds between the layers, so the layers can slide over each other, thus graphite is soft and slippery.



0 9

This question is about atomic structure and the periodic table.

Gallium (Ga) is an element that has two isotopes.

0 9 . 1

Give the meaning of 'isotopes'.

You should answer in terms of subatomic particles.

[2 marks]

Isotopes are atoms of the same element
with same number of protons but with
different number of neutrons.

0 9 . 2

Table 8 shows the mass numbers and percentage abundances of the isotopes of gallium.

Table 8

Mass number	Percentage abundance (%)
69	60
71	40

Calculate the relative atomic mass (A_r) of gallium.

Give your answer to 1 decimal place.

[2 marks]

$$\begin{aligned}
 R. AM &= \left(\frac{69 \times 60}{100} \right) + \left(\frac{71 \times 40}{100} \right) \\
 &= 41.40 + 28.40 \\
 &= \underline{69.8}
 \end{aligned}$$

Relative atomic mass (1 decimal place) = 69.8

Gallium (Ga) is in Group 3 of the modern periodic table.

0 9 . 3

Give the numbers of electrons and neutrons in an atom of the isotope $^{69}_{31}\text{Ga}$

[2 marks]

Number of electrons 31

Number of neutrons 38

$$\begin{aligned}\text{Neutrons} &= \text{Mass number} - \text{Atomic number} \\ &= 69 - 31 = \underline{38}\end{aligned}$$

0 9 . 4

What is the most likely formula of a gallium ion?

[1 mark]

Tick (✓) one box.

Ga⁺

☐

Ga⁻

☐

Ga³⁺

☒

Ga³⁻

☐

0 9 . 5

Gallium was discovered six years after Mendeleev published his periodic table.

Give **two** reasons why the discovery of gallium helped Mendeleev's periodic table to become accepted.

[2 marks]

- 1 Gallium filled the gaps left based on Properties.
- 2 Gallium's Properties were predicted correctly by Mendeleev.

Turn over ►



1 0

This question is about the extraction of metals.

Element R is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:



1 0 . 1

The sum of the relative formula masses (M_r) of the reactants ($3\text{H}_2 + \text{RO}_3$) is 150

Calculate the relative atomic mass (A_r) of R.

Relative atomic masses (A_r): H = 1 O = 16

[2 marks]

$$3\text{H}_2 + \text{RO}_3 = 150$$

$$(3 \times 2) + (16 \times 3)$$

$$6 + 48 = 54$$

$$\text{Relative atomic mass of R} = \frac{150 - 54}{1} = 96$$

Relative atomic mass (A_r) of R = 96

1 0 . 2

Identify element R.

You should use:

- your answer to question 10.1
- the periodic table.

[1 mark]

Identity of R = Molybdenum (Mo)



1 0 3

Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:



Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

[3 marks]

$$\text{Percentage atom economy} = \frac{\text{Total Mr of the desired product} \times 100\%}{\text{Total Mr of all reactants}}$$

$$\text{Reactants} = 119 + 32 + 12 =$$

$$= 163 \quad \% = \frac{119}{163} \times 100\%$$

$$= 73\%$$

Percentage atom economy = 73 %

Question 10 continues on the next page

Turn over ►



1 0 . 4 Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

Table 9 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 9

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide.

[4 marks]

Carbon and iron are the cheapest reactants while the hydrogen is the most expensive reactant. Separating solid products is expensive and time consuming. In Method 1, tungsten need to be separated from tungsten Carbide. This can be obtained by reducing tungsten oxide using Carbon, because it reacts with carbon to make tungsten Carbide. In Method 1 some tungsten is lost as tungsten carbide and Carbodiimide produced will escape. Method 2 the Water vapour produced will escape and no separation of solids is needed. Method 3 the tungsten needs to be separated from iron oxide

10

END OF QUESTIONS

